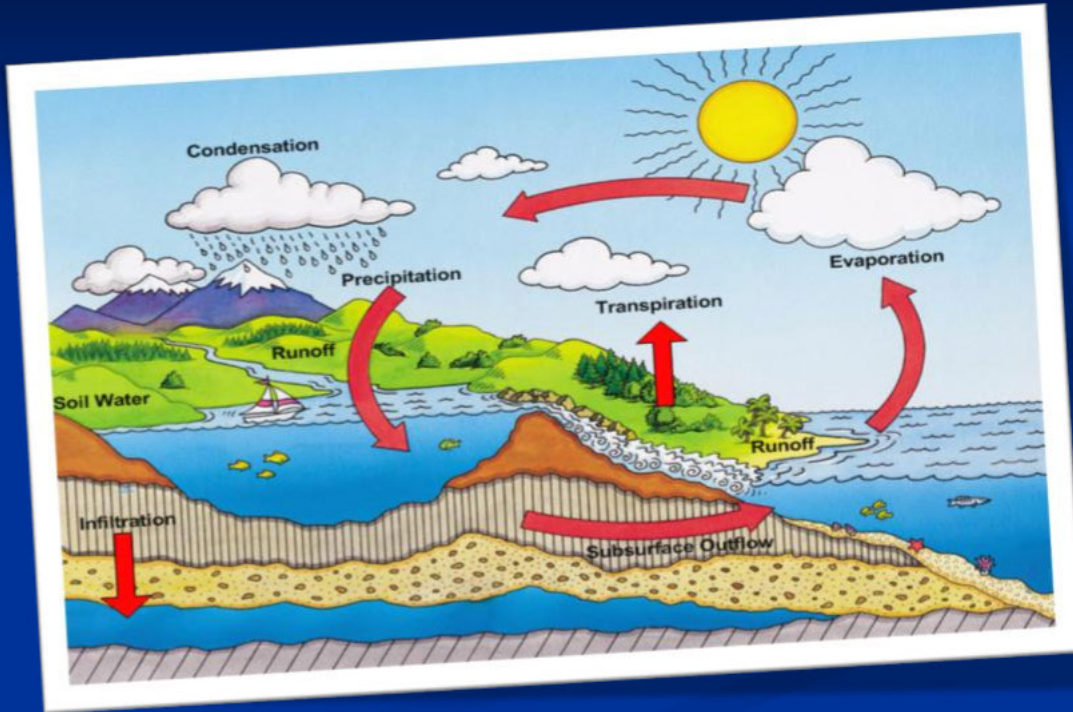


Slide 1 - Hydrology

Hydrology

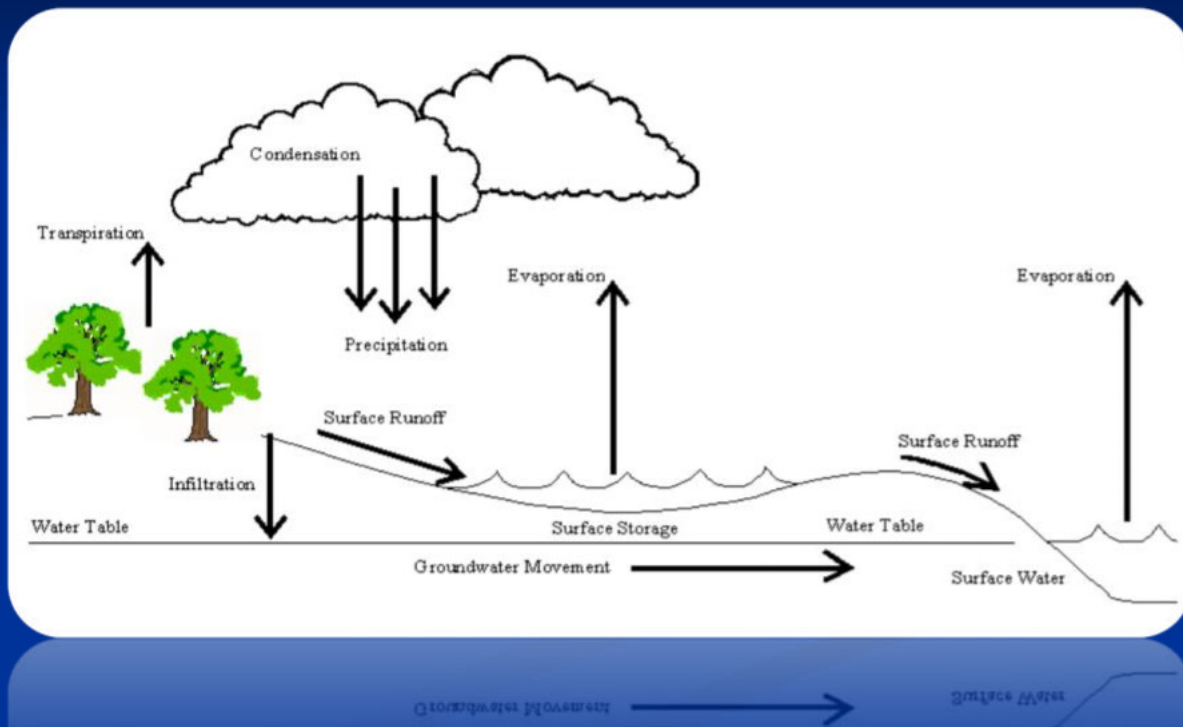
**Slide notes**

Hydrology is the science concerned with the origin, circulation, distribution , and properties of the waters of the earth.

Notes

Slide 2 - Hydrologic Cycle

Hydrologic Cycle

**Slide notes**

Precipitation falls to earth in the form of rain and snow. When rain falls on dry ground, some of the water will soak into the soil. This is infiltration. Water that does not infiltrate the soil, will flow as surface water runoff. This runoff is what causes erosion and carries sediments into ditches, storm pipes, streams, and other water bodies.

Notes

Slide 3 - Features Impacting runoff:

Factors Impacting runoff:

Size of drainage area

Shape of drainage area

Land use

Soil type, moisture & temperature

Slope

Precipitation

(snow & rain)

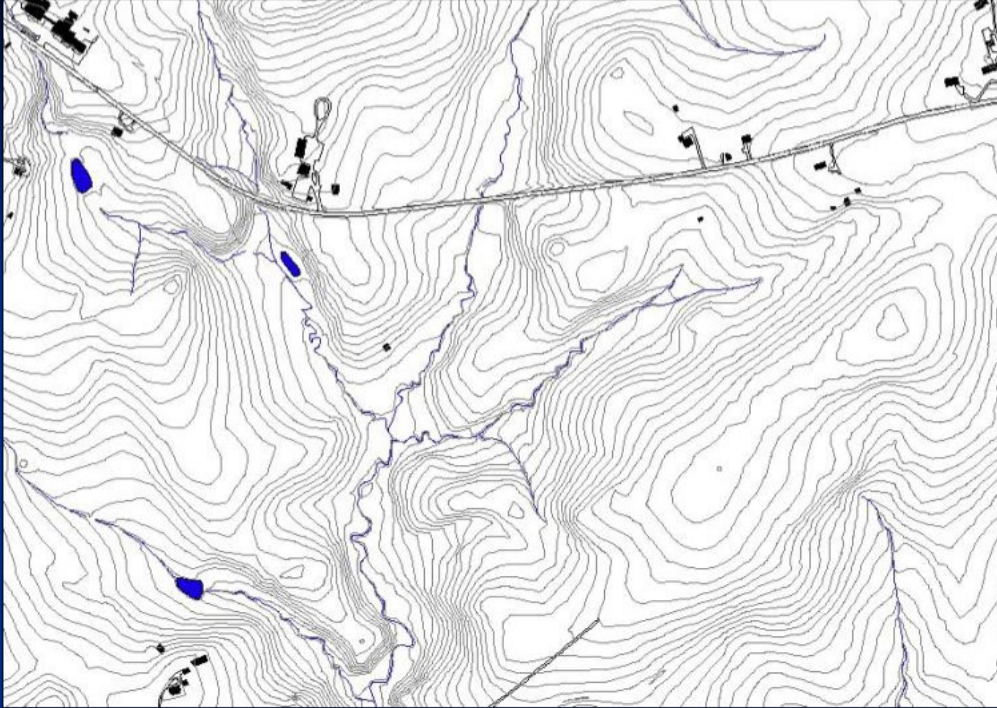
**Slide notes**

Runoff is influenced by a number of factors. You can see by the illustration that a lot more water flows over a parking lot (impervious surface) than over a vegetated area.

Notes

Slide 4 - Contour Maps

Contour Maps



- Determines direction of runoff
- Slope steepness
- Sheet flow vs. concentrated flow
- Use to determine drainage areas

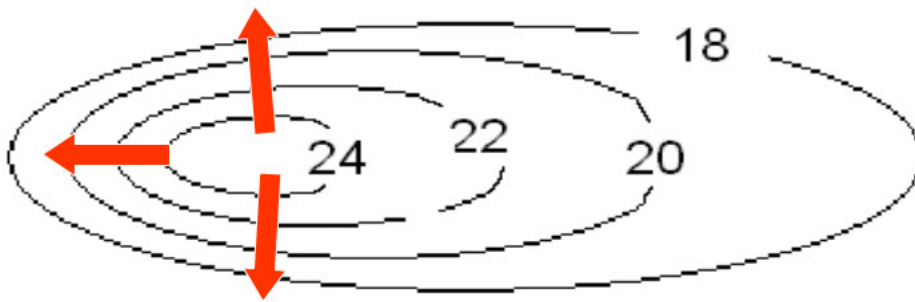
Slide notes

Before we can talk about slope and drainage areas, we need to discuss contour maps. The contour lines you see here are lines through points of equal elevation that represent the earth's surface. The elevation of these lines is measured in feet or meters from sea level. The following slides take a look at some land features seen on contour maps.

Notes

Slide 5 - Reading Contour Maps

Reading Contour Maps

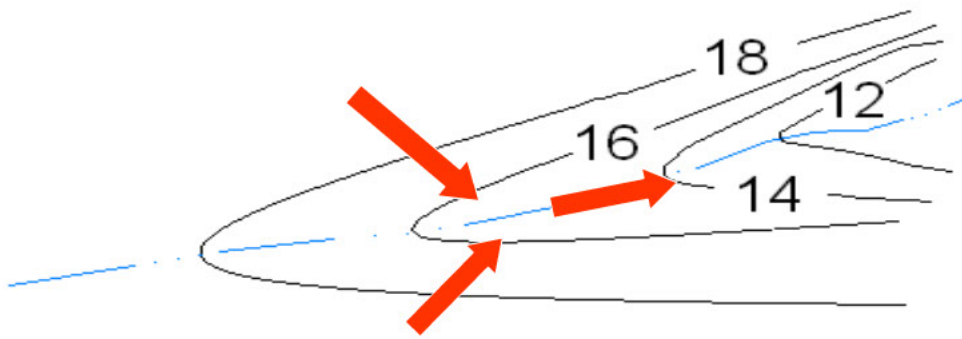
**Slide notes**

By the contour elevations, you know that rain falling on this area will flow from higher elevations to lower ones. Runoff flows perpendicular to the contour lines.

Notes

Slide 6 - Reading Contour Maps

Reading Contour Maps

**Slide notes**

The dashed and dotted line in this slide indicates stream flow. Contours with this configuration will indicate concentrated flow as in ditches and swales.

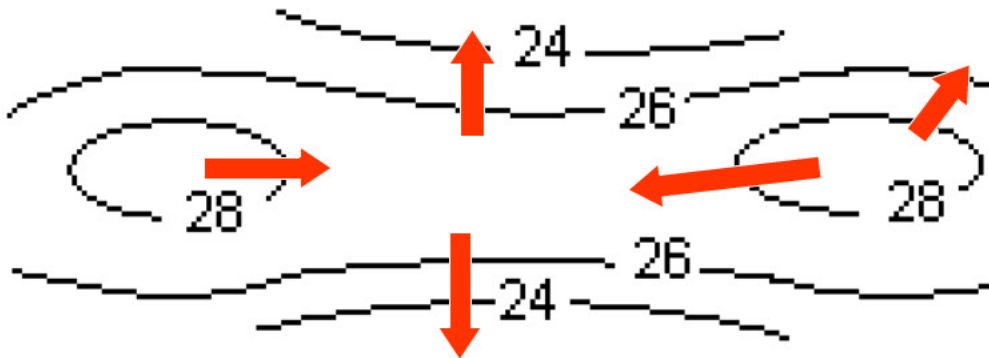
Notes

Slide 7 - Reading Contour Maps

Reading Contour Maps



Saddle, 2 High Points

**Slide notes**

A saddle is a dip or low point between two areas of higher ground.

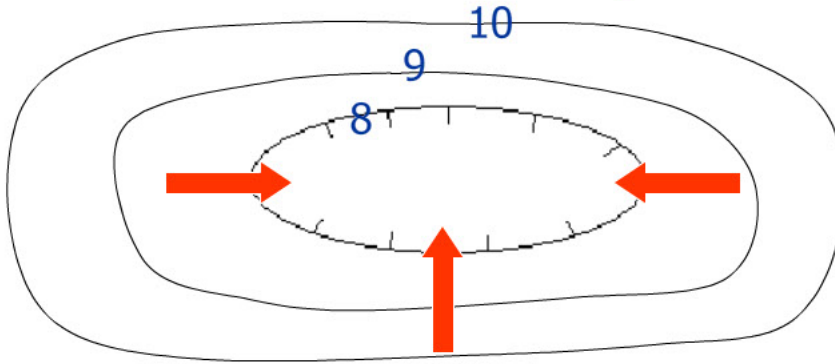
Notes

Slide 8 - Reading Contour Maps

Reading Contour Maps



Low Point or Sump

**Slide notes**

When runoff flows into a low point or sump, it will soak into the ground and/or evaporate into the air.

Notes

Slide 9 - Reading Contour Maps

Reading Contour Maps

Calculating % Slope = (change in elevation/distance) x 100

Find slope between A and B:

$$30 - 26 = 4$$

$$4 \div 60 = 0.07$$

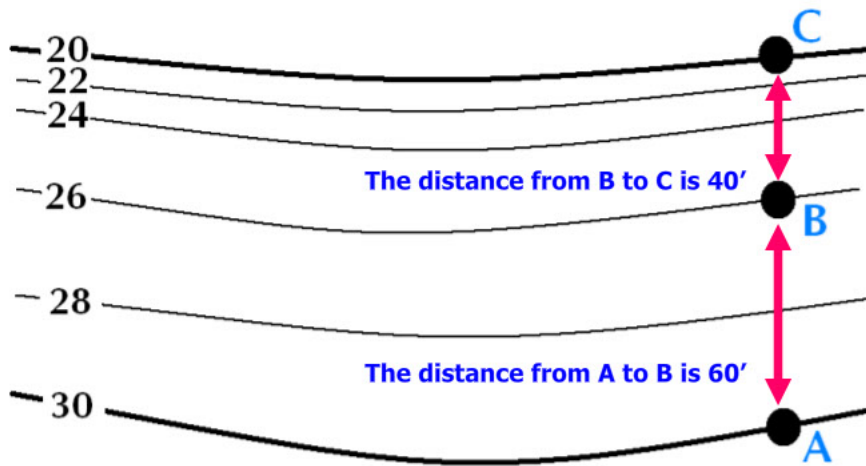
$$0.07 \times 100 = 7\%$$

Find slope between B and C:

$$26 - 20 = 6$$

$$6 \div 40 = 0.15$$

$$0.15 \times 100 = 15\%$$



Slide notes

If you want to determine the slope in a particular area, find the points of high and low elevation on a contour map. Then subtract the low elevation from the high elevation and divide the difference by the distance between the points. Multiply that number by one hundred and you will have the percent slope. Notice when contour lines are close together the slope is steeper than when they are spread apart.

Notes

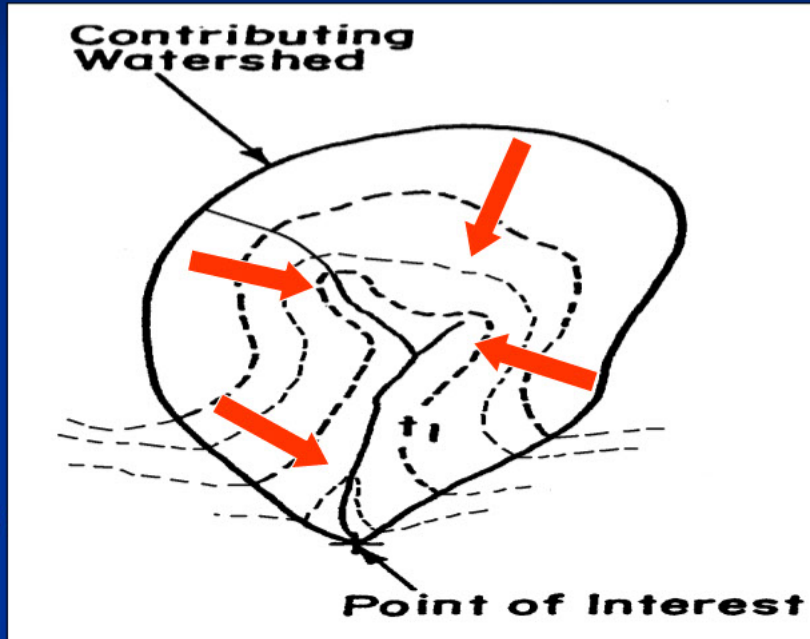
Slide 10 - Drainage Areas

Drainage Areas

- The total land area above a point that drains past that point

Delineating Drainage Areas:

- Determine point of interest (sediment trap, inlet, stone outlet structure)
- The surface water within this boundary flows to the study point
- Drainage area boundaries are perpendicular to contours
- Include storm drains and culverts



Slide notes

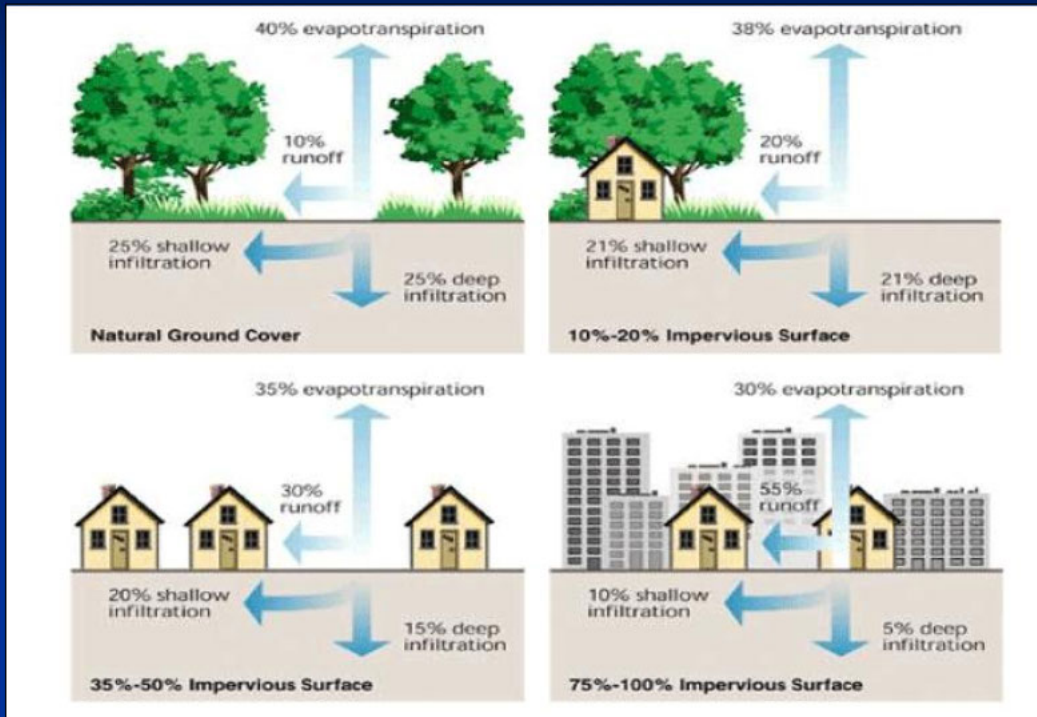
When we design storm drains, culverts, or erosion and sediment controls, we need to determine how much runoff will flow to the structure or control. In order to do this, we locate the point where the control will be constructed, and develop an area by drawing a boundary line perpendicular to the contours as shown. This line will end where it started creating a unique area that provides runoff to that point.

Notes

Slide 11 - Land Use

Land Use

Urbanization (i.e. removing vegetation) increases the runoff volume and flow rates within a drainage area

**Slide notes**

When the drainage area is determined, we need to look at how the land is used within that area. This slide illustrates how urbanization affects runoff volume and flow rates. Urban areas contain a high percentage of impervious surfaces like roads, houses, malls, parking lots, etc. These developed areas increase runoff volume and flow rates.

Notes

Slide 12 - Land Use

Land Use

Courtesy NRCS

Urbanization (i.e. removing vegetation) increases the runoff volume and flow rates within a drainage area

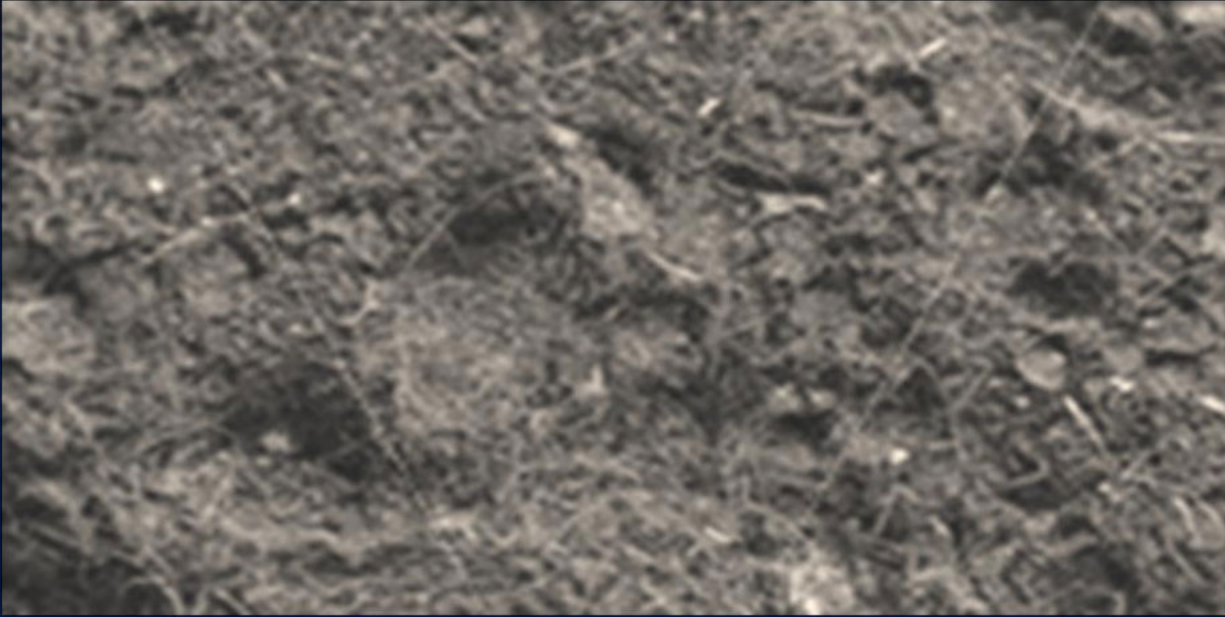
**Slide notes**

Even if this forest and meadow area were 10 times the size of the developed area on the right, the runoff produced from it would be less than that from the developed area..

Notes

Slide 13 - Soils

Soils



- Sand, loamy sand have low runoff rates;
- Clay loam, sandy clay, clay have higher runoff rates

Slide notes

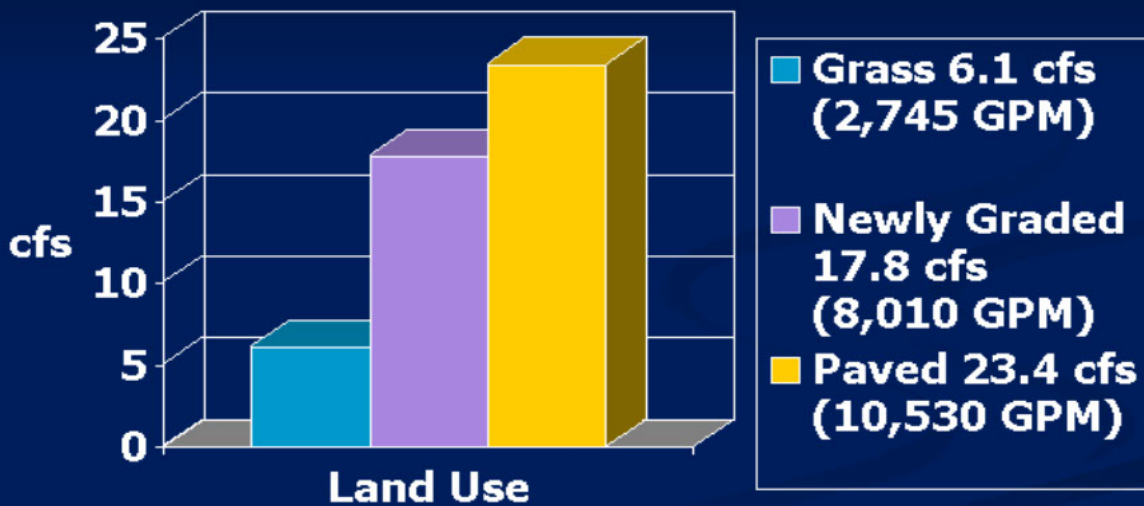
Another factor that influences runoff is the type of soil present within a drainage area. Sandy soils allow runoff to flow through or permeate the soil, while clay soils are compacted causing runoff to move over the surface.

Notes

Slide 14 - Comparison of Flow Rates

Comparison of Flow Rates

Flow Rates for Various Landuse



1 cfs (cubic feet per second) = 450 gallons per minute

Slide notes

Flow rate is a volume of water per unit of time. It is measured in cubic feet per second. This graph compares the flow rates over a 5-acre drainage area with different land uses. A 2-year, 24-hour storm has dropped 3.2 inches of rain. As you can see the flow rate over a grass surface is much lower than the flow rate over a paved surface.

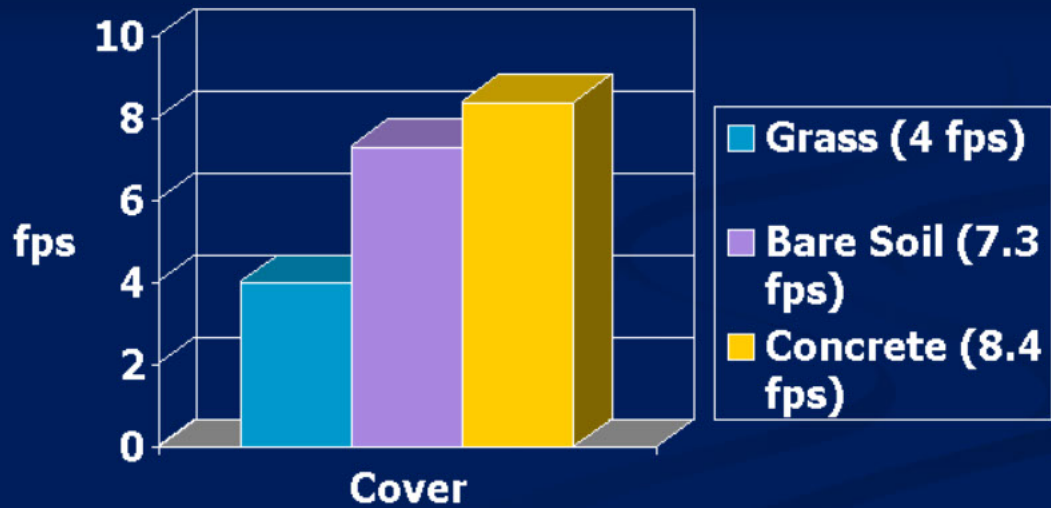
Notes

Slide 15 - Effects of Vegetative Cover V-ditch, 2:1 side slopes, S=2.0%

Effects of Vegetative Cover

V-ditch, 2:1 side slopes, S=2.0%

Velocity for Various Covers

**Slide notes**

This slide compares velocity of runoff over different land covers. Clearly, a vegetated cover slows the water down.

Notes

Slide 16 - Reducing velocity of flow

Reducing velocity of flow



Vegetative Cover
Surface Roughening

Check Dams
Flatten Slopes

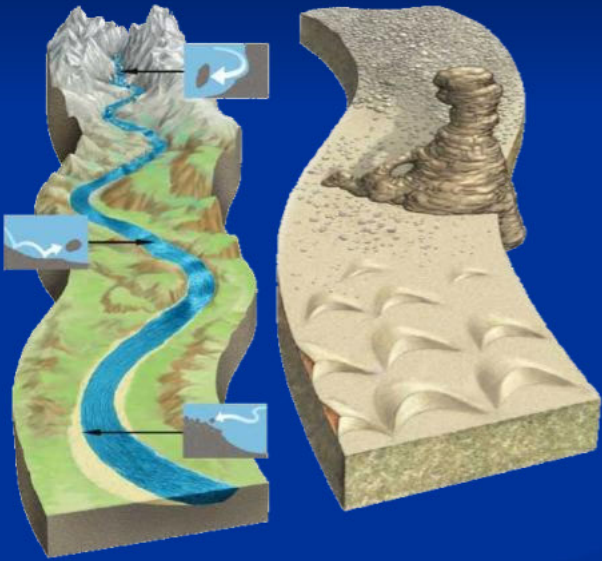
Slide notes

We have techniques to reduce velocity of flow. An established vegetated cover is the best way to reduce velocity. Surface roughening reduces velocity on graded slopes. Check dams reduce velocity in ditches and swales. Reducing steepness of slope also slows water.

Notes

Slide 17 - Erosion Mechanics

Erosion Mechanics

**Slide notes**

Now we will turn our attention to erosion and the factors that influence it.

Notes

Slide 18 - Natural Soil Erosion

Natural Soil Erosion



**Water
Wind
Ice
Gravity**

Slide notes

Erosion is a natural process wearing away land surface by the action of water, wind, ice, and gravity. It is responsible for many of our picturesque landscapes. Natural erosion produces about 30% of all sediment in the U.S.

Eroded soil is replenished by the weathering of rock & the decay of organic matter at a rate equal to what is removed.

Notes

Slide 19 - Accelerated Erosion

Accelerated Erosion

- Created by Man
- Caused by Clearing Land for:
 - Construction
 - Mining
 - Agriculture
 - Tree Harvesting

**Slide notes**

Accelerated erosion is caused by human activities accounting for about 70% of the erosion in the U.S.

Accelerated erosion removes soil faster than it can be replaced. In this training, we are concerned with construction activities and how development increases erosion.

Notes

Slide 20 - Accelerated Soil Erosion

Accelerated Soil Erosion



- **Removing Vegetation**
- **Compacting Soil**
- **Creating Impervious Surfaces**
- **Concentrating Flows**
- **Enlarging Drainage Areas**

Slide notes

Understanding the erosion process can help us prevent erosion and sedimentation.

When land is developed, vegetation is removed, soils are compacted, impervious surfaces are created, runoff is concentrated and existing natural drainage areas are changed.

Notes

Slide 21 - Effects of Accelerated Erosion

Effects of Accelerated Erosion

Sediment deposition in wetlands

High concentration of pollutants

Sediments fill reservoirs/shipping channels

Loss of fertile topsoil

High stream turbidity

Roadway washout

Bridge scour

**Fills & Clogs Storm
drains**



Slide notes

Accelerated erosion has a major impact on our state. Maryland has nearly 600,000 acres of wetlands, and excessive sediment runoff can lead to damage of these natural resources. A loss of soil requires more furnished topsoil and/or a need for amendments to establish vegetation in a disturbed area. Excessive runoff from lack of vegetation can also lead to pollutant transport of nutrients, hydrocarbons or heavy metals to nearby watersheds. Deposited sands in waterways cover fish spawning beds and suspended silts and clays reduce the light available to bottom plants. These effects can have a detrimental effect on not only our surrounding environment but also the food supply for local wildlife and humans.

Notes

Slide 22 - Factors Affecting Erosion

Factors Affecting Erosion

Soil**Land Cover/Vegetation****Topography****Rainfall****Slide notes**

Several factors affect the potential for erosion, such as soil types, vegetation, topography and rainfall amounts.

Notes

Slide 23 - Factors Affecting Erosion Soil

Factors Affecting Erosion Soil

Texture

Structure

Moisture

Temperature



Slide notes

The first factor is the soil itself; The properties that make up the soils will dictate how susceptible it is to erosion

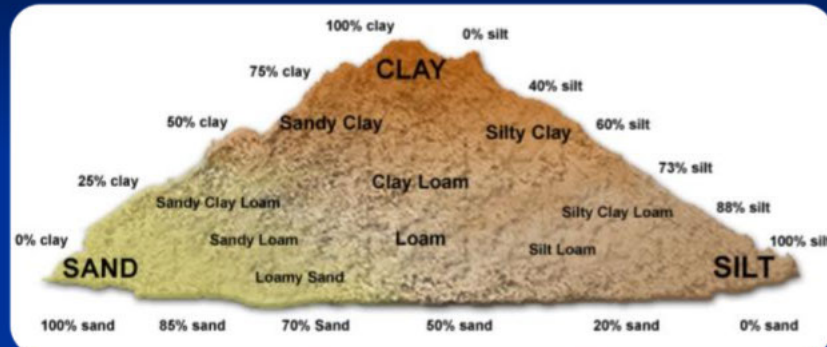
Notes

Slide 24 - Factors Affecting Erosion Soil Texture and Structure

Factors Affecting Erosion Soil Texture and Structure

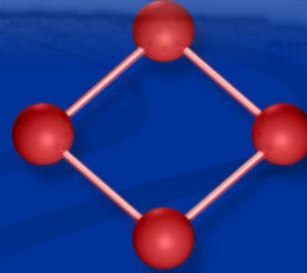
Texture is the relative proportion of sand, silt, and clay particles present.

Varying proportions result in higher or lower erosion potential.



Structure of the soil is its ability to aggregate into larger units.

This is the soils ability to aggregate into larger units. These units have greater mass [volume and weight] and are not as readily moved.



Slide notes

The texture of a soil helps us understand not only how likely it is to erode, but how quickly suspended particles fall out of the water column. Clay soils are less likely to erode than silty soils as the particles are tightly bound together (cohesive); however once erosion occurs, clay particles stay suspended in the water column enabling them to travel much longer distances.

Structure of a soil affects its potential to be eroded. As soil aggregates into larger units it is less likely to wash away.

Notes

Slide 25 - Factors Affecting Erosion Soil Moisture and Temperature

Factors Affecting Erosion Soil Moisture and Temperature

Moisture Percent of water in the soil.

Measure of amount of water in soil (V_w/V_t),
Optimum moisture content 10-30% for vegetative
establishment.

Too wet: excess runoff, difficult to establish/maintain
vegetation.

Too Dry: difficult to establish/maintain vegetation.

Temperature is a measure of warmth or
coldness of the soil.

Alternating freeze/thaw expands soil, increases moisture,
increases erosion, increases particle dislodgement.
Vegetation reduces variability of soil temperature.



Slide notes

The amount of water in a soil must be considered when establishing and maintaining vegetation. Optimum moisture content promotes the establishment and health of vegetation. In addition, saturated soils can no longer absorb rainfall which leads to increased runoff.

During winter months soil experiences freeze and thaw cycles. Saturated soils expand when frozen causing soil particles to dislodge and be prone to erosion. A good vegetative cover will help to reduce the variability of soil temperatures.

Notes

Slide 26 - Factors Affecting Erosion Land Cover/Land Use

Factors Affecting Erosion Land Cover/Land Use

Vegetation reduces erosion in several ways:

- Prevents soil sealing
- Shields soil from raindrop impact
- Increases evaporation
- Increases infiltration
- Reduces velocities
- Reduces runoff volumes
- Provides filtration (sediment control)



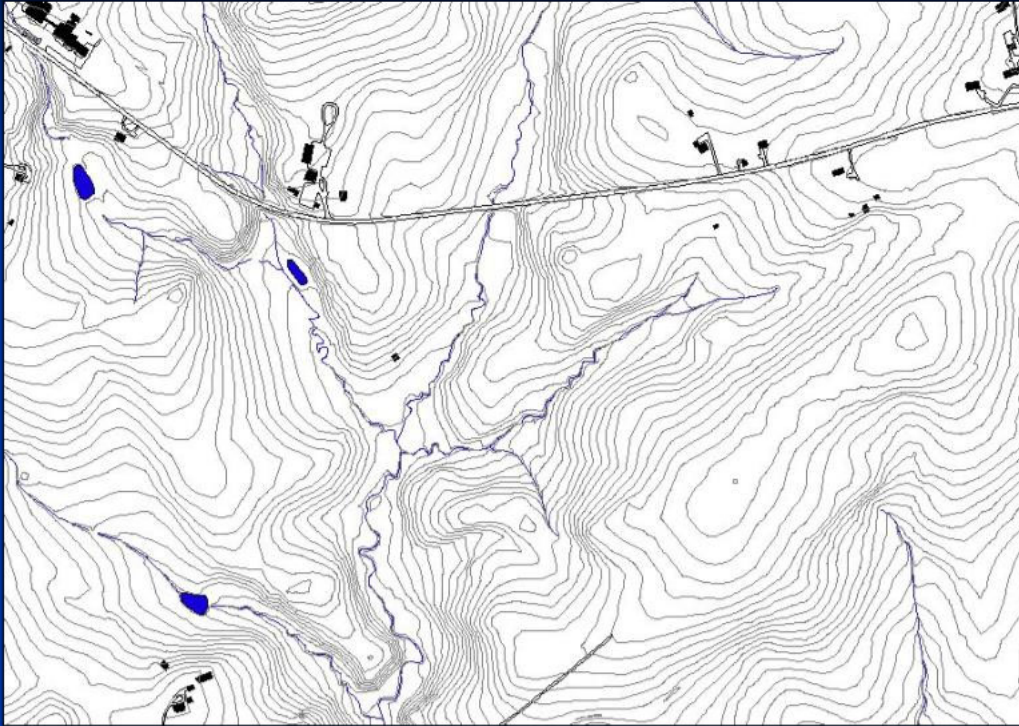
Slide notes

An established vegetative cover reduces the potential for erosion in several ways. When vegetation is removed, soil particles carried by runoff settle and fill spaces in the soil. This creates a sealed surface that won't allow water to penetrate. Vegetation protects the soil from raindrop impact, It increases evaporation and infiltration, It slows the water down, reduces runoff volume, and provides filtration

Notes

Slide 27 - Factors Affecting Erosion Topography

Factors Affecting Erosion Topography

**Slide notes**

The Degree or steepness of slope affects energy of the flow. Water flows with more energy over steep slopes and has the potential to create more erosion. Slope length affects the quantity or depth of flow. Depth and velocity affect turbulence. Turbulence and velocity affect erosion and transport of soil particles

Notes

Slide 28 - Factors Affecting Erosion Weather (Rainfall, Snow, Wind)

Factors Affecting Erosion Weather (Rainfall, Snow, Wind)

Depth**Intensity****Duration****Frequency****Slide notes**

Rainfall is the main cause of erosion in Maryland. On average it rains every three days in our state. As the intensity, duration and frequency of rainfall events increase, so does the potential for erosion. A large amount of rainfall in a short duration of time tends to wash over the surface of the ground instead of having the time to soak in naturally.

Notes

Slide 29 - Erosion Process

Erosion Process

Detachment
Transport
Deposition

**Slide notes**

The first phase of the erosion process is the detachment of soil particles. These particles can become separated by raindrop impact, freeze thaw cycles, wind, and snow melt.

The second phase is movement or transport of the particles. Water and wind can carry soil particles from a few inches to hundreds of miles. When water carrying soil particles loses energy particles are deposited as sediment.

Notes

Slide 30 - Types of Erosion

Types of Erosion



Splash Erosion

- **Raindrop Impact**
- **Breaks down soil structure**
- **Most influential factor in soil erosion**

Slide notes

Splash erosion is the most influential factor in the erosion process. Raindrops can hit soils at such high velocities individual particles can be moved up to two feet vertically and five feet horizontally.

Notes

Slide 31 - Types of Erosion

Types of Erosion

Sheet/Interill

- Thin sheets of erosion
- Transport of particles removed by splash erosion



Slide notes

Rain often falls at a rate faster than the soil's ability to absorb it. This results in runoff carrying soil particles in very thin layers called sheet erosion.

Notes

Slide 32 - Types of Erosion

Types of Erosion

Rill Erosion

- Concentrated Flow
- Micro channels
- Shear stress is primary factor



Courtesy Cranfield University

Slide notes

As runoff begins to concentrate rills will form. These are micro channels in which soil particles are removed from the sides by shear stress. Generally, where water erosion rates on disturbed upland areas are greatest, rills are active. Flow depths in rills are typically on the order of a few centimeters or less.

Notes

Slide 33 - Types of Erosion

Types of Erosion

Gully Erosion

- Severe erosion
- Large channels
- Costly to repair



Slide notes

Gully erosion occurs when runoff water accumulates, and rapidly flows in narrow channels during or immediately after heavy rains or melting snow. Gully erosion can remove soil to a considerable depth and become very costly to repair.

Notes

Slide 34 - Types of Erosion

Types of Erosion

Channel Erosion

- Streambed and streambank
- Scour
- Undercutting of streambanks



Slide notes

Overburdening streams increases the flow and can eventually lead to increased channel erosion in stream and rivers.

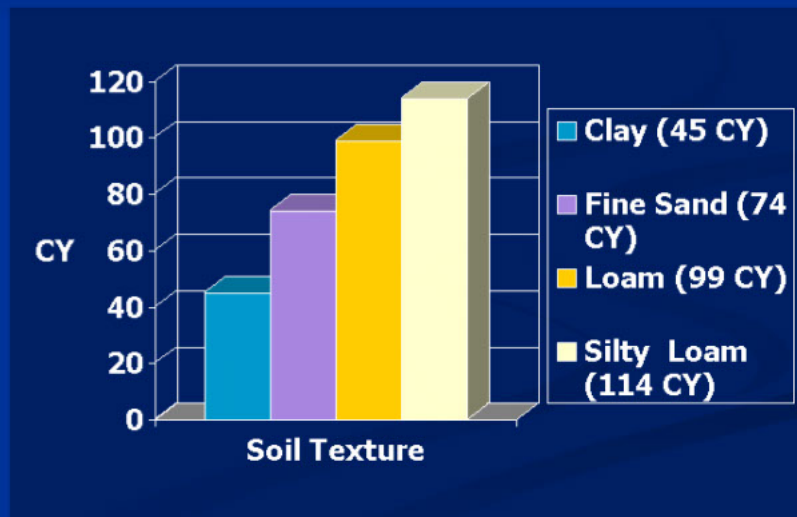
Notes

Slide 35 - Estimated Sediment Yields For Different Soils

Estimated Sediment Yields For Different Soils

Example Site Parameters:

3 Ac. site
20' fill
80' slope length
1" Runoff
Bare Soil

**Slide notes**

Let's take a moment to look at the amount of sediment that occurs from runoff over the site described in the slide. Sediment yields change depending on the type of soil. As can be seen here clays tend to erode less but remember they can travel much farther as clay tends to stay suspended on water for long periods of time.

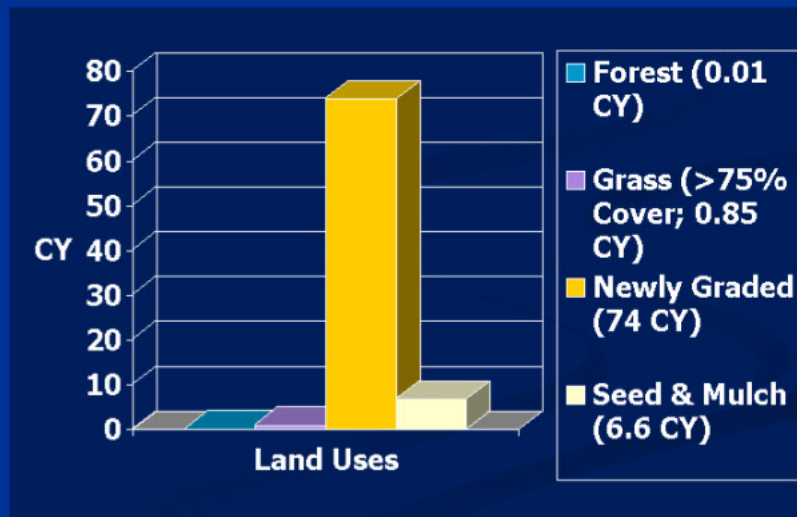
Notes

Slide 36 - Estimated Sediment Yields For Different Land Uses

Estimated Sediment Yields For Different Land Uses

Example Site Parameters:

3 Ac. site
20' fill
80' slope length
1" Runoff
Bare Soil

**Slide notes**

The land use can effect sediment yields. Removing vegetation can greatly effect sediment loss so keeping an area covered can help in reducing sediment loss.

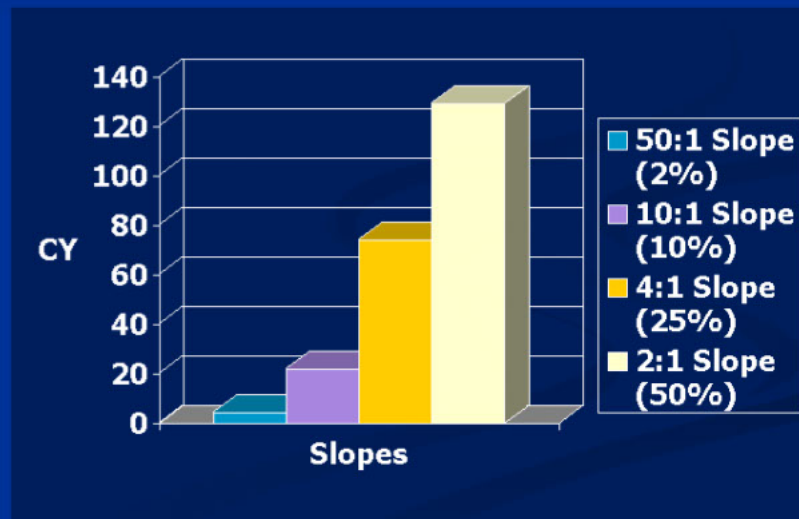
Notes

Slide 37 - Estimated Sediment Yields For Different Slopes

Estimated Sediment Yields For Different Slopes

Example Site Parameters:

3 Ac. site
20' fill
80' slope length
1" Runoff
Bare Soil

**Slide notes**

As can be seen here, the steeper a slope is constructed, the higher the sediment loss will be from that area as the water will travel much faster over the area and have less time to infiltrate back into the ground.

Notes

Slide 38 - End



Slide notes

This completes the Hydrology and Erosion Mechanics portion of the Yellow Card certification. To continue with the training please select the next training module from the menu on the left side of your screen.

Notes
